

GLAST Large Area Telescope: Status Report to SEUS

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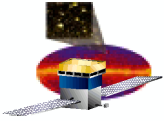
ritz@milkyway.gsfc.nasa.gov

see <http://glast.gsfc.nasa.gov>

and <http://www-glast.slac.stanford.edu> (LAT)

<http://gamma-ray.msfc.nasa.gov/gbm> (GBM)

<http://glast.sonoma.edu> (E/PO)



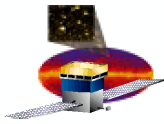
GLAST Science

GLAST will do great science, with a very broad menu that includes:

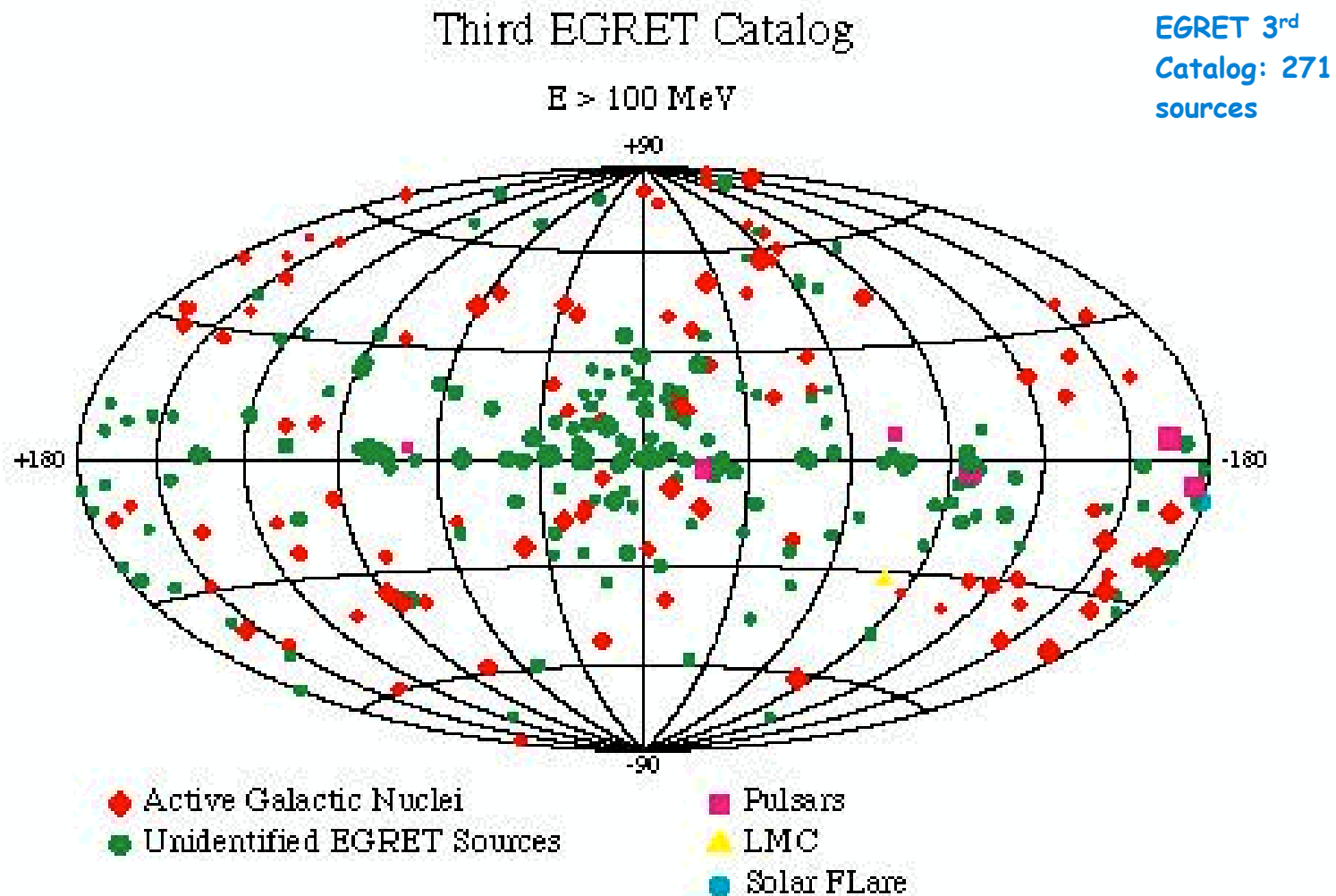
- **Systems with supermassive black holes**
- **Gamma-ray bursts (GRBs)**
- **Origin of Cosmic Rays**
- **Probing the era of galaxy formation**
- **Discovery! (Particle dark matter? Other relics from the Big Bang? Testing Lorentz invariance. New source classes.)**

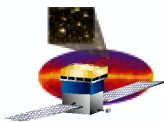
Factor 30-100 improvement in sensitivity for $E_{\gamma} > 100$ MeV, with huge FOV (20% of the sky).

GLAST connects the High Energy Particle Physics and High Energy Astrophysics communities.



Sources

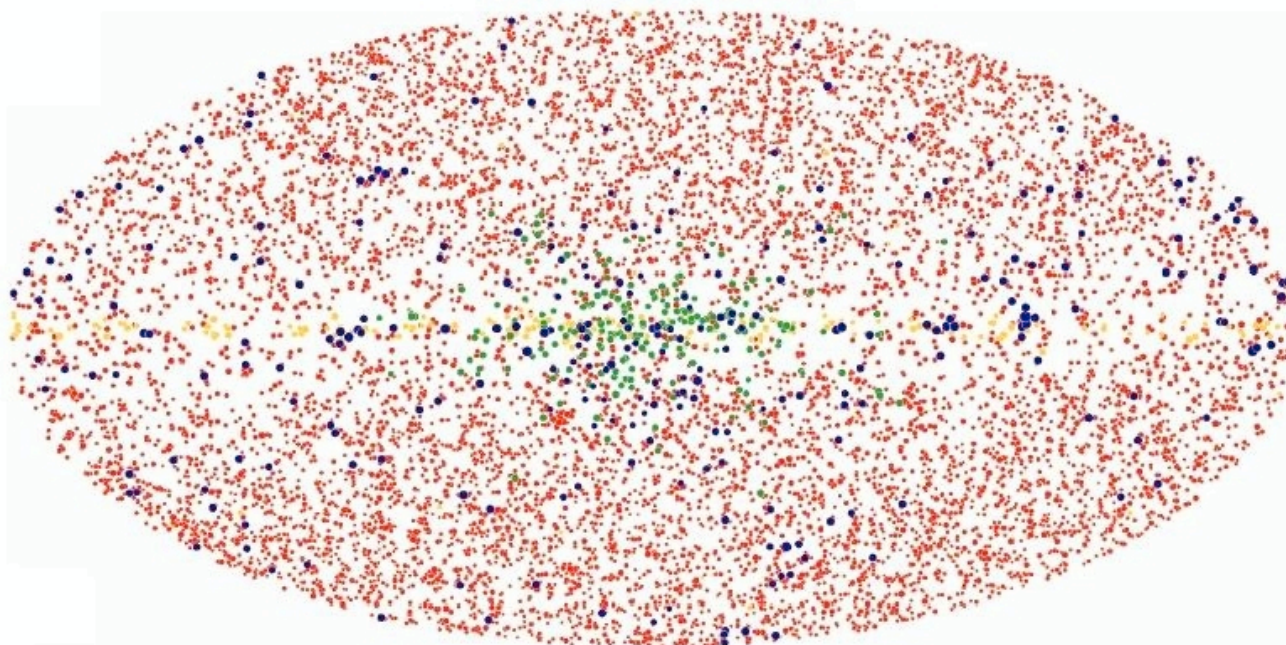




Sources

**5 σ Sources from Simulated
One Year All-sky Survey**

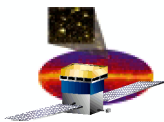
LAT 1st Catalog:
>9000 sources
possible



Results of one-year
all-sky survey.
(Total: 9900 sources)

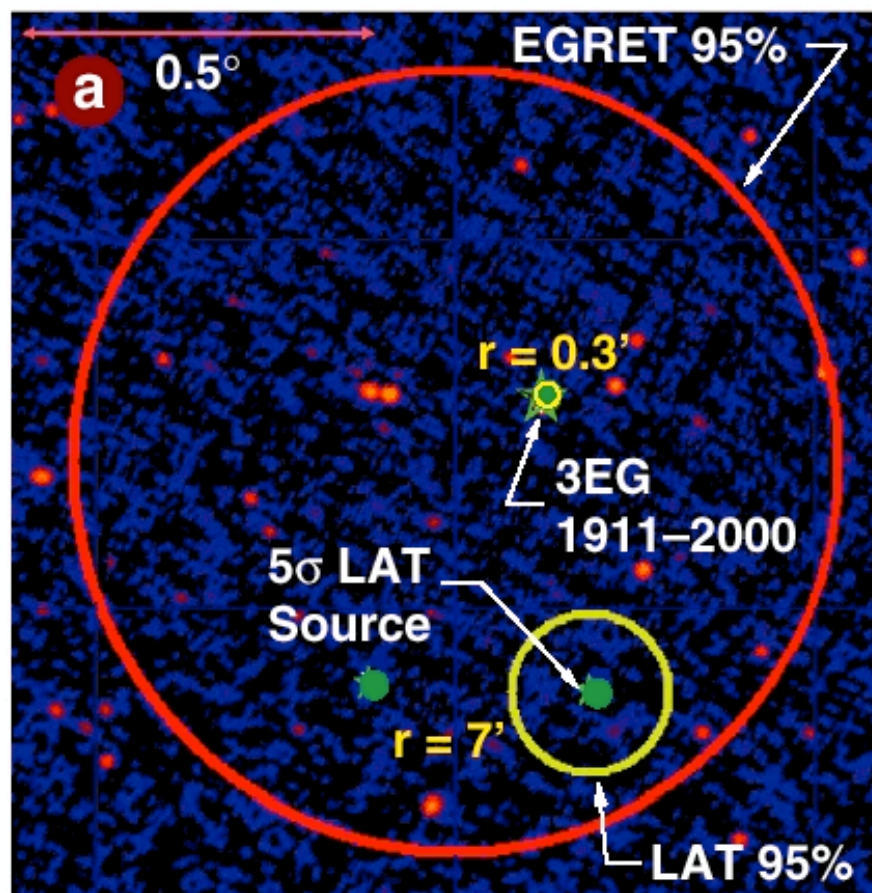
● AGN
● 3EG Catalog

● Galactic Halo
● Galactic Plane



Unidentified Sources

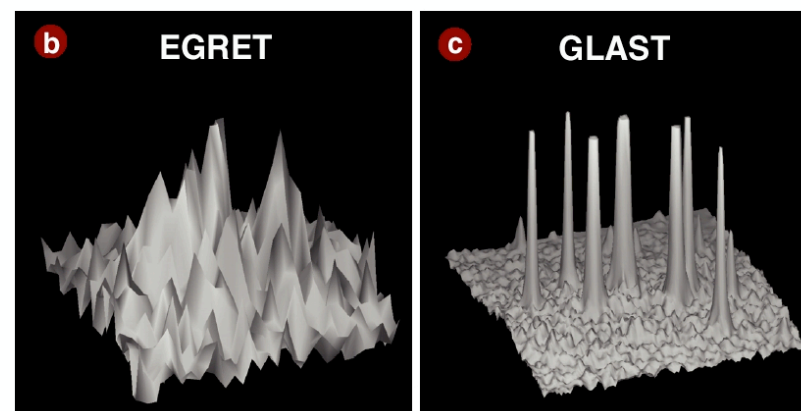
172 of the 271 sources in the EGRET 3rd catalog are “unidentified”



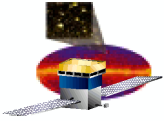
- Rosat or Einstein X-ray Source
- 1.4 GHz VLA Radio Source

EGRET source position error circles are $\sim 0.5^\circ$, resulting in counterpart confusion.

GLAST will provide much more accurate positions, with ~ 30 arcsec - ~ 5 arcmin localizations, depending on brightness.



Cygnus region (15x15 deg)



Outline

☐ Project

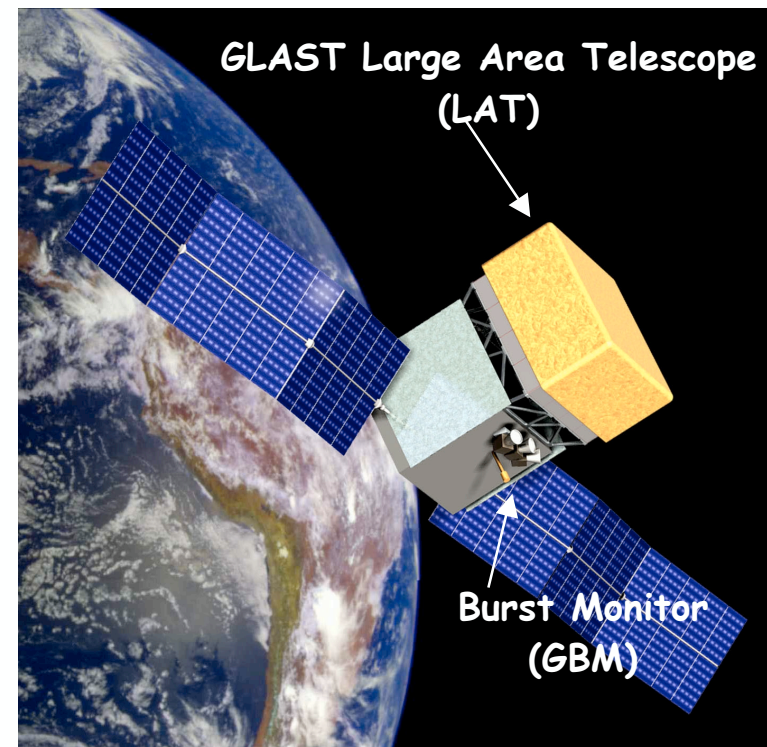
- Science Working Group/IDS's
- Science Support Center
- Spacecraft procurement

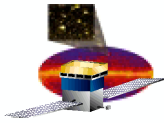
☐ E/PO

☐ LAT (20 MeV – >300 GeV)

☐ GBM (10 keV – 25 MeV)

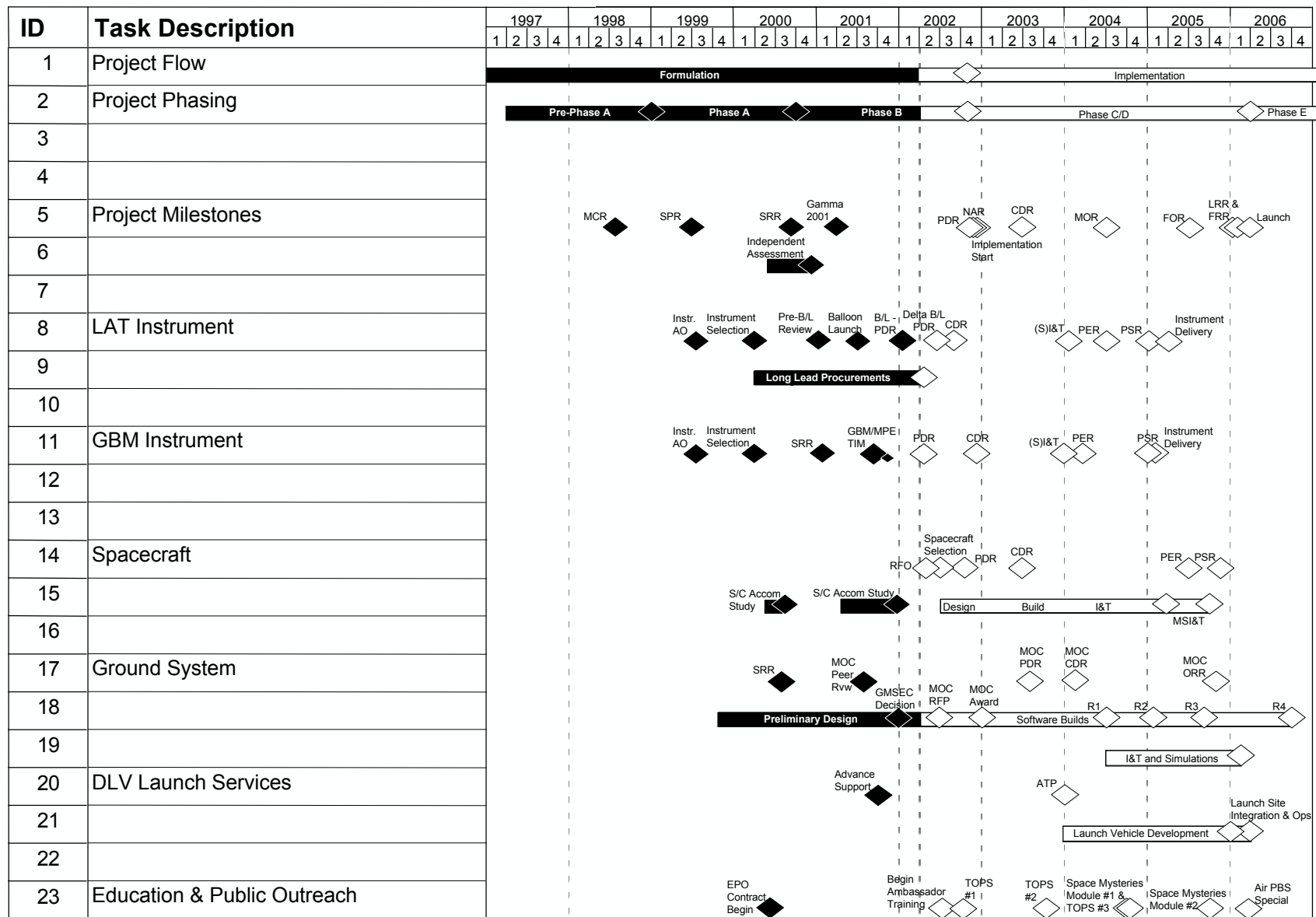
☐ Summary



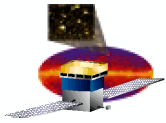


GLAST Project Master Schedule

3/31/02

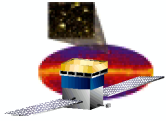


Rev 5 - 01/31/02



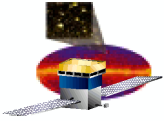
Project: Science Working Group

- Chaired by Project Scientist (Jonathan Ormes). Membership includes the Interdisciplinary Scientists and delegates from the instrument teams.
- Having bimonthly telecons and ~biannual sit-down meetings.
- Sit-down meetings have included daylong topical meetings directly involving the various communities: AGN (4/01 Baltimore, adjacent to **GAMMA2001**); Pulsars (12/01 UCSC); Bursts (planned for 9/02 Huntsville).
- Working groups on topics as needed, including observing planning (inputs to spacecraft design) and GRB coordination.
- see <http://glast.gsfc.nasa.gov/science/swg/> for meeting minutes and activities
- GLAST science sessions at major conferences. Suggestions welcome!



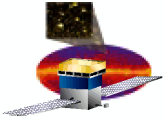
Project: Science Support Center Accomplishments

- Roles and responsibilities defined at the SSC-IOC interface:
 - SSC-LAT working group to define suite of science tools, establish software standards, and design key databases
 - SSC scientists will participate in developing tools with LAT team
 - SSC will have a backup Level 1 pipeline
- Staffing by mid-summer – Manager, Science Lead, 3 scientists, 2.5 scientific programmers, webmaster and administrative assistant (fraction of FTE)
- Documents
 - PMDP revised
 - SSC Functional Requirements Document revised
 - Report of GLAST Data Products Working Group (with draft ICDs)
 - Detailed WBS under development
- Event database under design



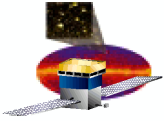
Project: SSC Near-term Plans

- Staffing
 - Documents
 - Finish PDMP, SSC Functional Requirements Document
 - Develop SSC WBS
 - Databases
 - Study and model organization of the event & photon databases
 - Level 2 Science Tools
 - SSC-IOC software working group to define tool suite
 - Establish standards, requirements, and deadlines
 - SSC scientists part of development groups
 - Response functions
 - Use of HEASARC CALDB in GLAST framework
-
- User Committee being formed



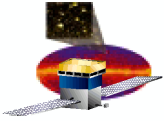
Project: Spacecraft Procurement

- Spacecraft will be procured through the Rapid Spacecraft Development Office (RSDO) as a fixed-price contract.
- Two previous accommodation studies with vendors surfaced many issues and helped sharpen requirements.
- IMDC run (2/02) as a check of the project's spacecraft baseline concept; useful as a benchmark in the proposal evaluation process.
- Draft RFO released. Expect final RFO out end of April, selection by mid-summer.



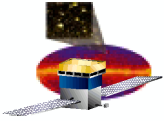
Project: Personnel

- Project continues to increase staffing as needed, particularly for system engineering (including new system engineer co-located at SLAC).
- Recent senior personnel changes:
 - Project manager: Liz Citrin [previously on MAP] (12/01)
 - Deputy project manager: Al Vernacchio (4/02)

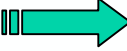


Project: Other Items

- Heavy launch vehicle (Delta 2920H) baselined for purposes of mission planning.
- Observatory c.g. being closely monitored.
- Working to minimize the chance of a premature end to the scientific mission due to presence of deorbit propulsion system.
- Impacts of X-band bandwidth limitation for space sciences missions being accommodated in Ops planning.



E/PO & PR Programs Summary

- GLAST Ambassadors program: Develop, distribute and field test GLAST material, train other teachers at local and national conferences. First five Ambassadors chosen, five more positions opening in 2004. Summer workshop @ SSU: July 02.
- GLAST exhibit booth 
- Printed materials
 - TOPS Learning Systems (2002-2004)
 - Active Galaxies poster now available. Over 3500 distributed so far this year.
 - GLAST EPO flyer part of SEU folders distributed – 10,000 distributed during 2001 teacher's conferences.
 - About 1000 GLAST Program flyers distributed
- PBS TV Show
 - Discussions with Tom Lucas are underway – negotiations ongoing w/ PBS
- Part of SEU Museum Exhibit (“Cosmic Questions”)
- GLAST Video now available on line -- 3000 CDs are being printed
- Science brochure and mission fact sheet; press releases; newsletter articles.
- Telescope network (w/ Mattox, RCT-Kitt Peak, others under discussion)

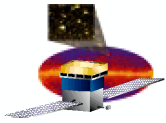
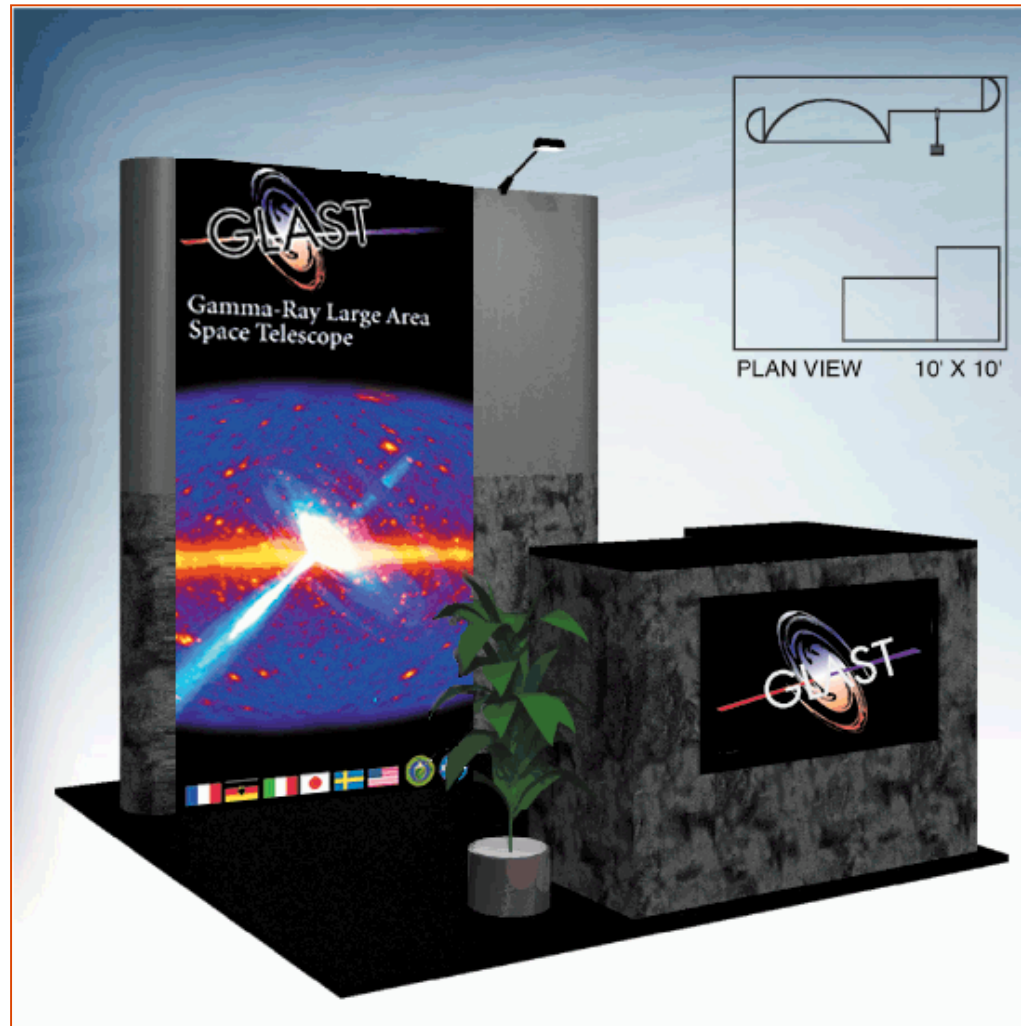
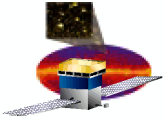


Exhibit Booth

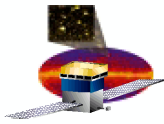
- AAS in DC in January 2002
- Expanding Your Horizons at SSU in March 2002
- AAS Albuquerque in June 2002





LAT Status (PI: Michelson)

- High-altitude balloon flight of prototype LAT tower; achieves all objectives – August 2001
- Flight hardware engineering model development underway
- NASA-DOE agreement signed January 2002!
- Reviews:
 - February 2001: first joint NASA-DOE LAT review
 - August 2001: joint NASA-DOE interim LAT review
 - January 2002: joint NASA-DOE PDR/Baseline review.
 - Result: LAT passes PDR “with flying colors”, except thermal subsystem which requires delta-PDR “due to a recently directed change to repackage the radiators to allow a maximum spacecraft diameter, and thus, the maximum number of potential spacecraft vendors to bid for the spacecraft contract.”. Of the 11 subsystems, 4 were not baselined (ACD, I&T, Mech/Thermal, Calorimeter). [DOE Baseline review includes a rigorous grassroots cost and schedule review – unusual for NASA projects at this stage.]
 - SLAC Director’s review April 16-18.
 - Delta PDR/Baseline review June 17-19 2002.



GLAST LAT Overview: Design

Si Tracker

pitch = 228 μm
8.8 10^5 channels
12 layers _ 3% X_0
+ 4 layers _ 18% X_0
+ 2 layers



ACD

Segmented
scintillator tiles
0.9997 efficiency
☐ minimize self-veto

Grid (& Thermal Radiators)

CsI Calorimeter

Hodoscopic array
8.4 X_0 8 _ 12 bars
2.0 _ 2.7 _ 33.6 cm
☐ cosmic-ray rejection
☐ shower leakage
correction



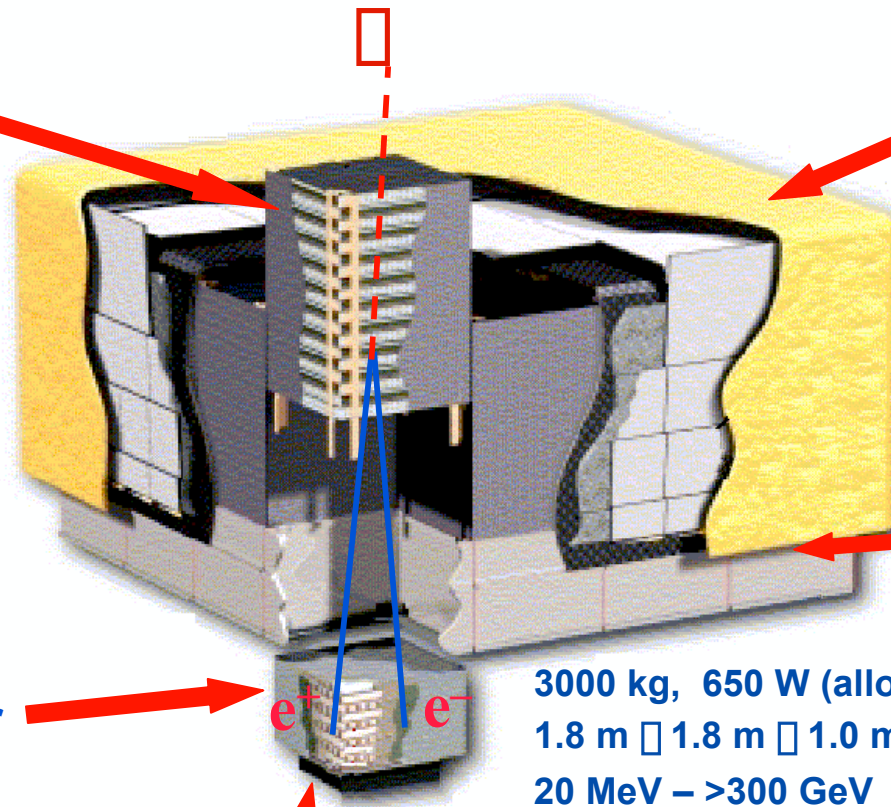
Data 
acquisition

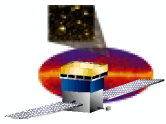
3000 kg, 650 W (allocation)
1.8 m \square 1.8 m \square 1.0 m
20 MeV – >300 GeV

LAT managed at
SLAC

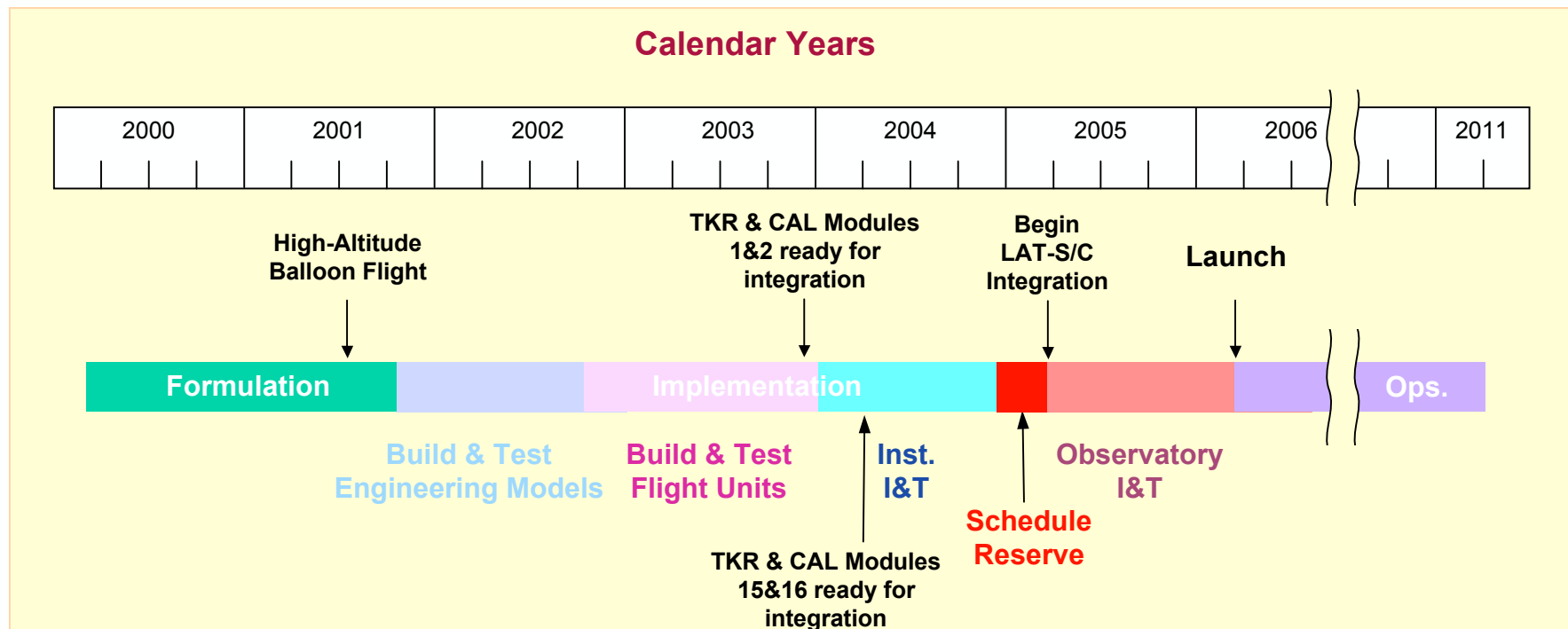
Flight Hardware & Spares

16 Tracker Flight Modules + 2 spares
16 Calorimeter Modules + 2 spares
1 Flight Anticoincidence Detector
Data Acquisition Electronics + Flight Software

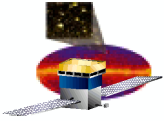




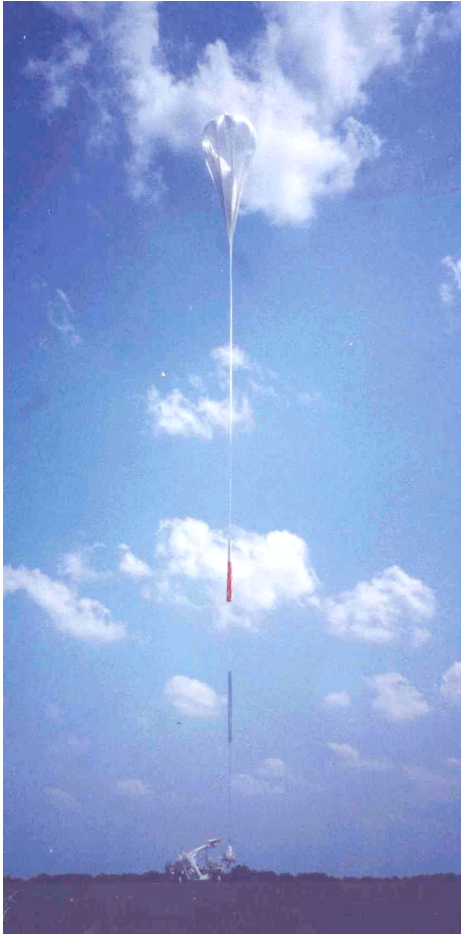
LAT Schedule



GLAST scheduled for launch in March 2006



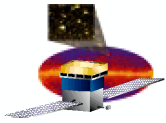
LAT Balloon Flight: Goals



Purpose of balloon test flight: expose prototype LAT tower module to a charged particle environment similar to space environment and accomplish the following objectives:

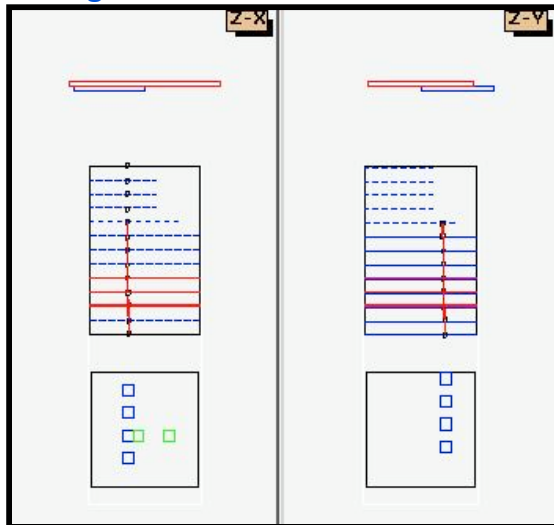
- ☐ **Validate the basic LAT design at the single tower level.**
- ☐ **Show the ability to take data in the high isotropic background flux of energetic particles in the balloon environment.**
- ☐ **Record events for use as a background event data base.**

**All Objectives met by Balloon Flight
on August 4, 2001**

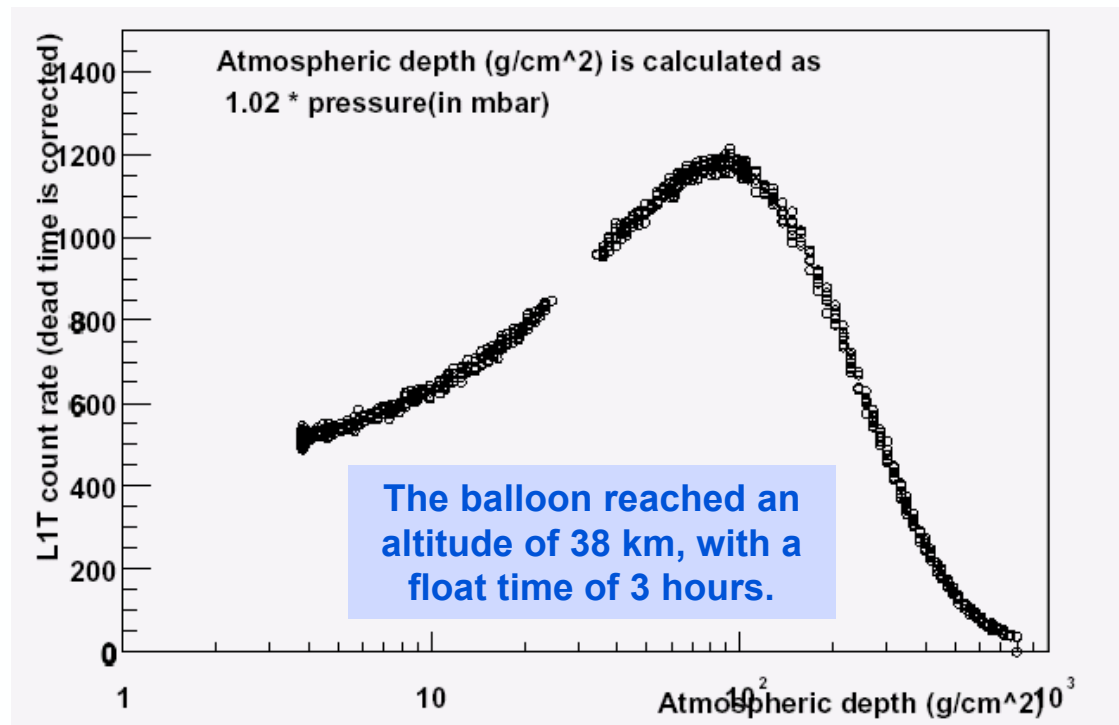
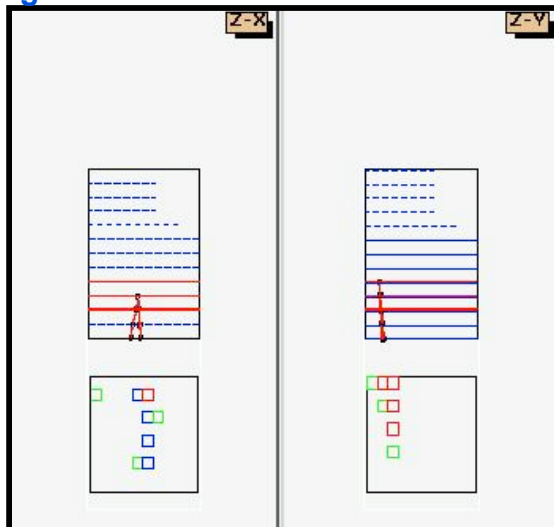


Flight and Operation: Launch on August 4, 2001

background event candidate:

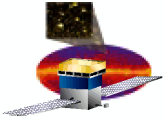


gamma event candidate:



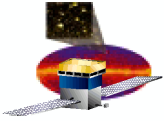
First results (real-time data): trigger rate as a function of atmospheric depth. The trigger rate never exceeded 1.5 KHz, well below the BFEM capability of 6 KHz.

All Subsystems Performed Properly



LAT Issue: Calorimeter and the CNES Situation

- **Background:**
 - March 5: CNES technical review recommends “pass” for French technical and management plans
 - However, R. Bonneville informs group that CNES funding severely impacted -- can likely only provide 1-2M Euros of planned (~8M Euros) CNES funding; (no previous indication that CNES funding was in jeopardy)
- **Actions taken:**
 - Letters and phone calls to CNES by IN2P3 and CEA/DSM directors, DOE, NASA, and prominent concerned scientists.
 - Commitment obtained from CEA management to push for full restoration from CNES and to maintain efforts on GLAST CAL in the meantime.
 - Meeting held on March 21 with CNES DG (Brachet) & Deputy DG (Bonnet) and IN2P3, CEA management and French LAT team leadership:
 - Urgency of situation communicated to CNES leadership, support expressed for French participation in GLAST, given French history of scientific work in the field and its importance
 - Brachet calls for emergency meeting of CNES Science Policy Committee to consider full restoration of planned CNES commitments
 - **Emergency meeting of CNES Policy Committee scheduled for April 19**



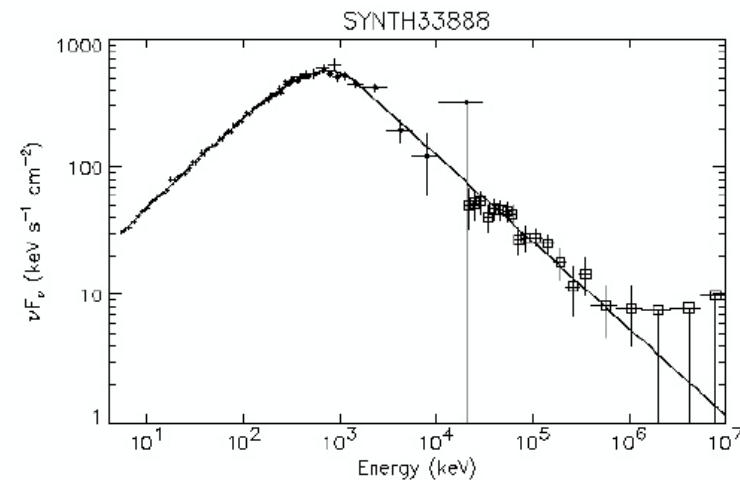
GBM (PI: Meegan)

- provides spectra for bursts from 10 keV to 30 MeV, connecting frontier LAT high-energy measurements with more familiar energy domain;

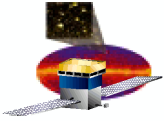
*Simulated GBM and LAT response to
time-integrated flux from bright GRB
940217*

*Spectral model parameters from CGRO
wide-band fit*

1 NaI (14 °) and 1 BGO (30 °)



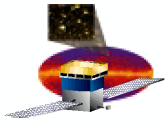
- provides wide sky coverage (8 sr) -- enables autonomous repoint requests for exceptionally bright bursts that occur outside LAT FOV for high-energy afterglow studies (an important question from EGRET);
- provides burst alerts to the ground.



GBM Status

- April, 2001: GBM funding included in NASA budget.
- July 27, 2001: Southwest Research Institute selected by MSFC to provide Data Processing Unit.
- Oct. 23, 2001: Jena Optronics selected by MPE to provide detectors and power supplies.
- Feb. 28, 2002: Increase in GBM mass allocation to 85 kg approved.
- March 7, 2002: Increase in GBM power allocation to 65 W approved.
- April 9-11, 2002: GBM PDR

There are no significant technical or management problems, and no changes to instrument capabilities.



GBM Collaboration



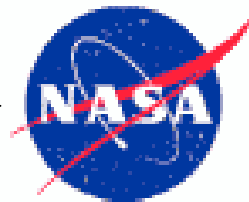
National Space Science & Technology Center



University of Alabama
in Huntsville

Michael Briggs
William Paciesas
Robert Preece

*On-board processing, flight software, systems
engineering, analysis software, and management*



Marshall
Space
Flight
Center

NASA
Marshall Space Flight Center

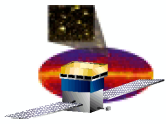
Charles Meegan (PI)
Gerald Fishman
Chryssa Kouveliotou



**Max-Planck-Institut für
extraterrestrische Physik**

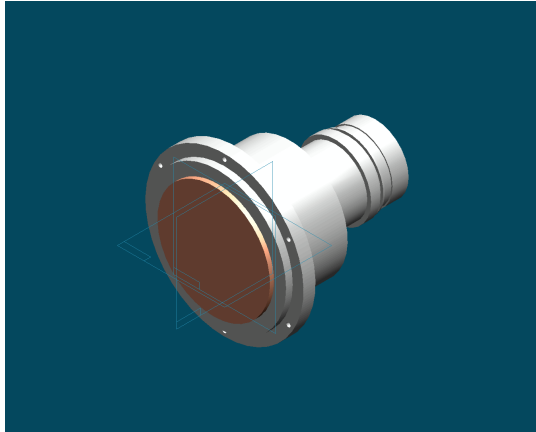
Giselher Lichti (Co-PI)
Andreas von Keinlin
Volker Schönfelder
Roland Diehl

*Detectors, power supplies,
calibration, and analysis software*



GBM Instrument Design: Major Components

12 Sodium Iodide (NaI) Scintillation Detectors



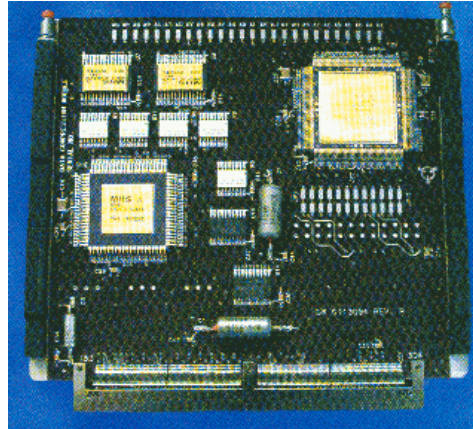
Characteristics

- 5-inch diameter, 0.5-inch thick
- One 5-inch diameter PMT per Det.
- Placement to maximize FoV
- Thin beryllium entrance window
- Energy range: ~5 keV to 1 MeV

Major Purposes

- Provide low-energy spectral coverage in the typical GRB energy regime over a wide FoV
- Provide rough burst locations over a wide FoV

Data Processing Unit (DPU)



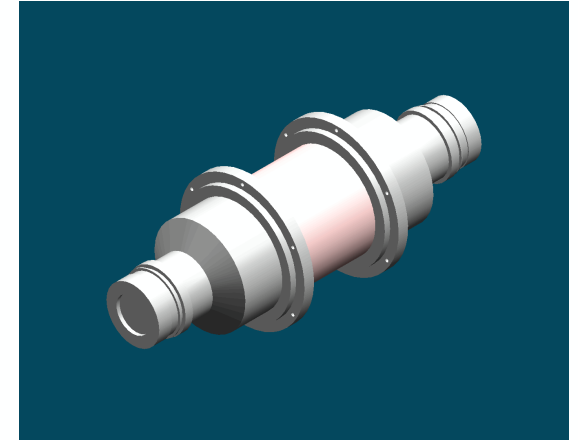
Characteristics

- Analog data acquisition electronics for detector signals
- CPU for data packaging/processing

Major Purposes

- Central system for instrument command, control, data processing
- Flexible burst trigger algorithm(s)
- Automatic detector/PMT gain control
- Compute on-board burst locations
- Issue r/t burst alert messages

2 Bismuth Germanate (BGO) Scintillation Detectors

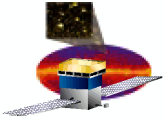


Characteristics

- 5-inch diameter, 5-inch thick
- High-Z, high-density
- Two 5-inch diameter PMTs per Det.
- Energy range: ~150 keV to 30 MeV

Major Purpose

- Provide high-energy spectral coverage to overlap LAT range over a wide FoV



Summary

- Project:
 - Ramping up science preparations (SSC, SWG, Instrument teams)
 - Spacecraft procurement process in full swing
 - Mission PDR in October
- LAT:
 - Successful balloon flight
 - Successfully completed PDR, with one delta-PDR/baseline (for Thermal system) scheduled; delta-baseline review for 3 additional subsystems in June.
 - NASA-DOE agreement paves the way for remaining international agreements
 - CNES funding issue pending
 - Building engineering models of flight hardware
- GBM:
 - Main vendors selected
 - PDR this week
- E/PO:
 - vibrant and broad program; cooperation with other missions (e.g., SWIFT)